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# Utilization of Waste Leaves of *Beta Vulgaris*, *Brassica Oleracea* and *Oryza sativa* Flakes for the Development of Iron-rich Vermicelli

Singh Richa<sup>1</sup>, Sharma Luxita<sup>2</sup>

Department of Dietetics & Applied Nutrition, Amity University, Haryana, India.

## ABSTRACT

**Introduction:** Nutritional enhancement of traditional foods is gaining a lot of importance nowadays. Also, utilization of unexplored food items is being considered. It has been seen that intake of food prepared from the leaves has expanded, but some leaves like cauliflower greens and Beetroot greens have a higher waste ratio and are generally discarded.

**Aim:** The study was conducted to utilize these leaves to formulate a product that is rich in iron and will be a better counterpart to the conventional product. Rice flakes were also used to increase the nutritional content of the product.

**Methods:** Rice vermicelli was prepared by using iron-rich powder. The iron-rich powder was obtained by mixing powder of beet greens and cauliflower greens in the ratio of 50:50. Four variations of the product were prepared viz., Sample A, sample B, sample C and sample D with a 10g, 15g, 20g and 25g incorporation of iron-rich powder. Physico-chemical characteristic of the developed products was also determined like cooking loss, water absorption, swelling index etc. Sensory evaluation of the developed products was carried out using a 9-point hedonic scale.

**Results:** Sample B i.e. 15g incorporation was found to be the most acceptable sample. Proximate analysis showed the iron content of the developed product to be 4.25mg/100g.

**Conclusion:** The development of novel and nutritious food products can be carried out using unexplored and unutilized sources of vegetables. This will ensure valorization of the developed food product and also food & nutrition security.

**Key Words:** Beetroot leaves, Cauliflower greens, Iron-rich vermicelli, Gruel loss, Swelling index, Water absorption, Waste utilization

## INTRODUCTION

Several nutritional deficiencies are prevalent in the Indian subcontinent for a very long time. Since, the launch of various nutritional programmes and schemes for improving the nutritional status of the population, a lot have been achieved, but still, there is a lot left to be done. A large population of the country is still undernourished and suffers from Malnutrition.

A comprehensive report of the Food and Agricultural Organization stated that 190.7 million people i.e. 14.5% people were undernourished during 2014- 2016.<sup>1</sup> Major micronutrient deficiencies are mainly about Iron, Iodine and Vitamin A. Many nutritional deficiencies were the reason for 0.5% of the total deaths in the country in the year.<sup>2</sup> This nutritional burden of hidden hunger is a major reason which also af-

fects the country's economic growth. According to Stein & Quaim, 2007 this malnourishment can cost up to 0.8 to 2.5 % of the country's gross domestic product.<sup>3</sup>

Nutritional enhancement of already existing food products is being followed throughout the world. Some of these practices are quite conventional while some have been novel in their approach. Also as a means of ensuring nutritional security, exploitation of underutilized foods is gaining significance. This approach can be a benchmark to ensure per capita availability of food, hence safeguarding food security.<sup>4</sup>

As stated earlier, one of the major micronutrient deficiencies is that of Iron, which leads to Iron deficiency anaemia. Anaemia is a major nutritional problem that is ignored throughout the world, whether in developing or developed countries. The World Health Organization (WHO) defines anaemia as the condition where the haemoglobin (Hb) value is less than

### Corresponding Author:

Singh Richa, Department of Dietetics & Applied Nutrition, Amity University, Haryana, India.

Email: richasingh.karma@gmail.com

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13 g/dL in men, less than 12mg/dL in non-pregnant women, and less than 11 g/L in pregnant women.

The major incidence of Iron deficiency can be manifested in growing children, women in the reproductive age group, pregnant women, the elderly and people suffering from chronic diseases.<sup>5</sup> To combat this nutritional problem, several strategies have been formulated throughout the world, these include Oral/intravenous iron supplements, dietary education, nutritional awareness and food fortification. Out of all these, food fortification or Biofortification is the most promising and lasting approach which can enhance the micronutrient status amongst the beneficiaries.<sup>6</sup> Thus, the food-based approach focuses on enhancing the nutritive value of an existing food product and can be carried out on a household level. The utilization of green leaves of cauliflower and beetroot for the development of Iron-rich vermicelli is the main endeavour with which this study is undertaken. Green vegetables are rich in nutrients and dietary fibre. They have fewer calories and fat but are excellent sources of vitamins like A, K, and C, carotenoids, folate, manganese.

Cauliflower (*Brassica oleracea*) is a very common and easily available vegetable, which is consumed by one and all. According to a review article by Sagar et al., 2018, the global production of cauliflower and broccoli was about 24.17 million metric tonnes, which is humongous.<sup>7</sup> Cauliflower greens fall in the category of leafy greens which have a higher proportion of Iron but these are generally discarded or either used for animal fodder.<sup>8,9</sup> Apart from being highly nutritional as in terms of a good amount of Iron and Beta carotene, they also have a higher waste index, because these are generally discarded.<sup>10</sup>

Beetroot is also called Chukandar in Hindi. Its scientific name is Beta Vulgaris L. It is the taproot portion of the plant which is commonly consumed. It belongs to the family Chenopodiaceae. Beetroot leaves are also one of the most underutilized vegetables which are highly nutritious.<sup>11</sup> The iron content of Beetroot leaves is even better than that of spinach.<sup>12</sup> It is being assumed that the nutritional composition of beet leaves is similar to the beetroot which is rich in carbohydrates, fibre, protein, and many minerals such as Sodium, Potassium, Calcium as well as Iron.<sup>13</sup> Some of the phytonutrients present in beetroot includes polyphenols, carotenoids, Betacyanins, Betaxanthins, etc.<sup>14</sup>

Rice flakes are obtained from paddy and these are some of the very versatile ingredients which can be used in numerous ways. Some other names which it is known by are Poha, Aval, or Avalakki.<sup>15</sup> It is considered to be a good source of iron owing to its production process, which requires the rice to be passed through iron rollers. This enables the flaked rice to retain some of the iron from the rollers.<sup>16</sup> Hence, these can be used as a low-cost, easily available source of iron to fortify various food products.

Vermicelli is a very commonly consumed extruded food product. It is traditionally prepared from whole or refined wheat flour, which is kneaded into a semi-hard dough. The prepared dough is either passed through an extruder and cold extrusion is carried out. Sometimes, the small pieces of dough are rolled using fingers and broken manually in the form of vermicelli. The formed vermicelli is laid out on sheets and sun-dried.<sup>17</sup>

## MATERIALS & METHODS

The present study was conducted in the Nutrition Lab of the Department of Dietetics & Applied Nutrition of Amity University Haryana, Gurgaon, India.

### Procurement and Processing of Ingredients

**Beetroot Leaves & Cauliflower Greens:** Fresh beetroot leaves and Cauliflower along with greens were collected from the nearby vegetable market of Panchgaon, Haryana. Damages, wrinkled, yellow, and old leaves were discarded and only green undamaged medium-sized leaves were selected. The greens were removed from cauliflower and saved for further use. The cauliflower greens (Leaves and juicy stem) and also the beetroot leaves were washed under running tap water to remove any impurities from the surface.

Washed leaves of beetroot were blanched for 2 minutes. The blanching was carried out by putting leaves in hot boiling water for 2 minutes and then placing them in cold water immediately. The blanched leaves were placed on an absorbent paper to remove excess moisture. After that, the leaves were sun-dried for 2 days.

The cauliflower greens were cut into small pieces to ensure even drying under the sun. Sun-drying was carried out for 3 days.

To ensure complete drying, the sundried beetroot leaves and cauliflower greens were further dried in a laboratory hot air oven at 60 °C.

The dried beetroot leaves and cauliflower greens were powdered using a household grinder and passed through a sieve to ensure even texture. The prepared Beetroot leaves to powder and Cauliflower greens powder were mixed in equal quantities and stored in an airtight container which was labelled as an Iron-rich mix.

**Rice Flakes:** Packaged rice flakes/poha was purchased from a nearby departmental store of Panchgaon, Haryana. The procured rice flakes were converted into a powdered form by grinding in the household grinder. The ground poha was passed through a sieve to obtain a flour-like consistency.

**Development of Iron-rich vermicelli:** Refined wheat flour (*Triticum aestivum*), rice flakes powder (*Oryza sativa*),

Beetroot leaves powder (*Beta vulgaris*) and Cauliflower greens powder (*Brassica oleracea*) were used for the preparation of four variations of Iron-rich vermicelli viz. Sample A, B, C, and D. The four samples varied from each other based on their composition. The variation of ingredients used for the preparation of 4 samples is mentioned in table no. 1.

All four ingredients were mixed and kneaded into a hard dough using an adequate amount of water. The prepared dough was passed through a household press and cold extruded into vermicelli and sundried subsequently.

**Physico- Chemical analysis of Iron-rich Vermicelli:** The developed iron-rich vermicelli was subjected to proximate analysis for moisture, ash, fat, fibre, protein, carbohydrate, and Iron by AOAC methods.<sup>18</sup>

**Sensory Evaluation:** The developed iron-rich vermicelli was subjected to sensory evaluation by a 20 membered semi-trained panel of judges. All four variations were evaluated organoleptically for appearance, taste, texture, flavour, and overall acceptability using a 9-point hedonic scale.<sup>19</sup>

**Cooking Quality:** The developed iron-rich vermicelli was cooked in water until the inner core was softened. To ensure that the product is cooked, a strand of vermicelli was pressed between thumb and index finger.

**Solid Gruel Loss:** Mestres et al., 1988 devised a method for determining Solid loss.<sup>20</sup> Weighted sample of developed iron-rich vermicelli was cooked in an adequate amount of water. Once cooked, it was strained out and the remaining filtrate was transferred to a pre-weighed petri dish. The contents of the petri dish were evaporated over heated water bath and then kept in a laboratory hot air oven for an hour. The weight of the petri dish was again taken and solid gruel loss was calculated using the formula mentioned below:

$$\text{Solid Gruel Loss} = \frac{W2 - W1}{W} \times 100$$

Here, the Weight of the sample taken for cooking is denoted as “W”

The initial weight of the petri dish is denoted as W1

The final weight of the petri dish is denoted as W2

**Water Absorption:** It is the ratio between the weight of the cooked vermicelli to the weight of vermicelli in a raw uncooked state.<sup>21</sup>

$$\text{Water Absorption in \%} = \frac{\text{weight of cooked vermicelli} - \text{the weight of raw vermicelli}}{\text{weight of raw vermicelli}} \times 100$$

**Swelling Index:** Cleary and Brennan, 2006 have instigated the method for determining the swelling index.<sup>22</sup> To determine swelling index a weighted sample of vermicelli i.e. 10

g was cooked in 200 ml (20 times) of boiling water for 10 minutes over a water bath maintained at 100 °C. After cooking the excess water was decanted and the vermicelli was dried to remove extra moisture on a filter paper. The cooked sample was weighed.

$$\text{Swelling index} = \frac{W2 - W1}{W1} \times 100$$

Here, the weight of the product before cooking is denoted by “W1” and weight of product after cooking is denoted by “W2”

## RESULTS & DISCUSSIONS

**Sensory Evaluation:** All the four variations of the developed Iron-rich vermicelli were subjected to sensory evaluation by a 20 membered panel of semi-trained judges. Sensory scores of all the samples of the developed product are mentioned in Table no. 2. The sensory evaluation scores showed Sample B i.e. the one with 15 grams of Iron-rich powder as the most acceptable sample. Attributes like taste, mouthfeel, flavour and overall acceptability were found to be the highest in the case of Sample B. Highest score for appearance was given to Sample A, followed by Sample B, C, and D. Due to the addition of Iron-rich powder, the colour variation was seen which affected the appearance of the samples, higher quantities of Iron-rich powder imparted a dark colour to the samples which affected their appearance in both cooked and raw state.

There were slight variations in the perception of taste in Samples A & B, while the other two samples i.e. C & D received fewer scores for taste from panel members.

The addition of iron-rich powder imparted a peculiar mouthfeel to the developed product which was not found to be acceptable as the quantity of Iron-rich powder increased. However, it did not have much effect on the flavour of the product, which is quite evident from almost similar scores for Sample A, B, and C.

Therefore, sensory evaluation scores of the developed product showed the incorporation level up to 15% to be acceptable by the panel members.

**Nutrient Composition:** The proximate analysis was also carried out. In this study, the nutrient composition of the most acceptable product i.e. Sample B was done using standard techniques. The iron content of the developed and most acceptable product is 4.25 mg/100g, which is approximately 23 % of the daily iron requirements. The addition of green leafy vegetables in the cooked product can also help in enhancing the iron content and also ensure increased bioavailability. Table no. 3 shows the nutritional composition of the

most acceptable sample i.e. Sample B.

**Cooking Loss/Solid Gruel Loss:** Gruel loss can be defined as the number of dissolved solids in the cooking water. It is an indicator of the structural integrity of the developed product.<sup>23</sup> Higher gruel loss will indicate a poor cooking performance for the vermicelli. The structural integrity of the product is directly dependent upon the raw materials used. According to Krishnan et al., 2012 a dense structure will result in lower cooking loss and hence a better product.<sup>24</sup> Addition of refined flour provided greater stability to the structure of vermicelli due to the presence of gluten and hence gave a stable structure to the product which also contained rice flakes and powdered leaves. It can be observed from the result that the cooking loss increased with an increase in the amount of Iron-rich powder. Sample D showed the highest cooking loss while the most acceptable variant i.e. Sample B showed a gruelling loss of 10.6%.

**Water absorption:** This characteristic is also an important measure of cooking quality. As per the results tabulated in Table no. 4, it can be seen that there are only slight variations in the values of water absorption in the case of all four samples. However, it can also be observed that with an increase in the content of iron-rich powder, the water absorption also increases. Similar studies have also reported an increase in water absorption with the addition of carrot powder.<sup>25</sup>

**Swelling Index:** These values showed a downward trend with increased content of the iron-rich powder. This may be attributed to the relationship between starch and fibre. An increase in the amount of fibre can lower the swelling of starch granules and lower swelling indices. But the Samples A, B, and C show slight variations in the swelling index. The lowest values are recorded in the case of Sample D. A study conducted by Padalino et al., 2017 also indicated a lower swelling index with the amount of tomato peel powder in developed spaghetti.<sup>26</sup>

All the tests about the cooking quality of the developed Iron-rich vermicelli have been tabulated in Table no. 4.

## CONCLUSION

It can be concluded from the present study that dried leaf powder of beetroot and cauliflower, which are generally discarded and have a higher waste ratio. These green leaves are nutrient-dense but seldom find a place in the diet of people due to ignorance and lack of awareness. In this study, these have been utilized for enhancing the nutrient content of the developed vermicelli, which is much higher than its conventional counterpart. Keeping the same aim of nutritional enhancement in mind, rice flakes powder has also been incorporated for further value enhancement. This study is also one of the food-based strategies for tackling nutrient (Iron) defi-

ciency. Hence, through this study, an effort has been made to boost nutrition and food security.

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### Conflict of Interest

There is no conflict of interest.

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NIL

Individual Author's Contribution

All work related to the literature review, product development, testing of the product has been carried out by both the authors jointly. The manuscript is also written jointly.

## REFERENCES

1. FAO, IFAD, UNICEF, WFP and WHO, The State of Food Security and Nutrition in the World. Building resilience for peace and food security. Food and Agricultural Organization of the United Nations; 2017.
2. India State-Level Disease Burden Initiative Collaborators. Nations within a nation: Variations in epidemiological transition across the states of India, 1990-2016 in the Global Burden of Disease Study. *Lancet* 2017; 390: 2437-60.
3. Stein AJ, Qaim M. The human and economic cost of hidden hunger. *Food Nutr Bull* 2007; 28: 125-34.
4. P. Joshi, B. Mathur, Bioavailability of Iron from the Leaf Powders of Dehydrated Less Utilized Green Leafy Vegetables, *Asian J. exp. biol. sci.* 2010; 1(4):845- 854.
5. Cappellini, M.D. Iron deficiency across chronic inflammatory conditions: International expert opinion on definition, diagnosis, and management. *Am. J. Hematol.* 2017; 92: 1068–1078.
6. Meenakshi, J.V. How cost-effective is biofortification in combating micronutrient malnutrition? An ex-ante assessment. *World Dev.* 2010; 38: 64–75.
7. Sagar NA., Fruit and Vegetable waste: Bioactive compounds, Their extraction, and Possible Utilization. *Compr rev food sci f.* 2018; 17: 512-531.
8. Boer K, Pandey A. "India's Sleeping Giant: Food", *McKinsey Q.* 1997; 83(1).
9. Ambika Chauhan, *Int J Nutr Agric Res.* 2014; 1(2): 93 - 98.
10. Kowsalya, S, Sangheetha, M. Acceptability and nutrient profile of cauliflower leaves (*Brassica oleracea* var. *Botrytis*). *Indian J Nutr Diet.* 1999; 36: 332-338.
11. Biondo P.B.F, Evaluation of beetroot (*Beta vulgaris* L.) leaves during its developmental stages: a chemical composition study. *Food Sci Technol (Campinas).* 2013; 34(1): 94-101.
12. Joshi, P, Mathur, B. Preparation of value-added products from the leaf powders of dehydrated less utilized green leafy vegetables. *J. Hortic. For.* 2010; 2(9): 223 – 228.
13. Ninfali P., Nutritional and functional potential of *Beta vulgaris* *cicla* and *rubra*. *Fitoterapia.* 2013; 89: 188-199.

14. Strack, D., Vogt, T, Schliemann, W. Recent advances in betalain research. *Phytochemistry*. 2003; 62(3): 247–269.
15. Deepa C., Singh V. Nutrient changes and functional properties of rice flakes prepared in a small scale industry. *Oryza* 2011; 48 (1): 56-63.
16. <https://www.krishisewa.com/articles/pht/999-production-technique-of-paddy-s-value-added-product-poha-or-flaked-rice.html>. Accessed on 15. 2. 2021.
17. Mogra R.; Midha S. Value addition of traditional wheat flour Vermicelli. *J Food Sci Technol*. 2013; 50(4): 815–820.
18. A.O.A.C. Official Methods of Analysis. Association of Analytical Chemists, Washington, DC. 2005; 18.
19. Swaminathan M, Food science, chemistry, and experimental foods. Bangalore Printing and Publishing Co. Ltd., Bangalore. 1987.
20. Mestres C, Colonna P, Bullion A. Characteristics of starch networks within rice flour noodles and mung bean starch vermicelli. *J Food Sci*. 1998; 53: 1809-1812.
21. AACC. Approved methods of the American Association of cereal chemists. St Paul Minnesota. 2005.
22. Cleary, L, Brennan, C. The influence of (1→3) (1→4)  $\beta$  glucan rich fraction from barley on the physicochemical properties and in vitro reducing sugars release of durum wheat pasta. *Int. J. Food Sci. Technol*. 2006; 41:910-918.
23. Li. P., Lu, W., Hseih, Ch. Li. T., Huang D. Rheological properties of dough and quality of slated noodles supplemented with djulis flour. *J. Agric. Sci*. 2015; 7(6): 84-92.
24. Krishnan, J.G., Menon, R., Padmaja, G., Sanjeev, M.S, Moorthy, S.N. Evaluation of nutritional and physicochemical characteristics of dietary fibre enriched sweet potato pasta. *Eur. Food Res. Technol*. 2012; 234(3): 467-476.
25. Kohajdová Z., Karovičová J., Jurasová M. Influence of carrot pomace powder on the rheological characteristics of wheat flour dough and wheat rolls quality. *Acta Sci. Pol. Technol. Aliment*. 2012; 11: 381–387.
26. Paulino, Lucia, Functional pasta with tomato by-products as a source of antioxidant compounds and dietary fiber. *Czech J. Food Sci*. 2017; 35(1): 48-56.

**Table 1: Variation of ingredients for the preparation of Iron-rich Vermicelli**

Ingredients	Sample A	Sample B	Sample C	Sample D
Rice flakes powder	45g	45g	45g	45g
Beetroot Leaves powder & Cauliflower greens powder (Iron rich mix)	10g	15g	20g	25g
Refined wheat flour	45g	40g	35g	30g

**Table 2: Sensory Evaluation scores of the Four variations of Iron-rich vermicelli**

Samples Attributes	Sample A	Sample B	Sample C	Sample D
Appearance	9.7+0.67	8.7+0.94	8.4+1.68	7.2+1.54
Taste	9.1+1.10	9.1+1.28	8.8+0.91	7.8+1.68
Mouthfeel	9.4+0.51	9.4+0.69	8.6+0.94	7.5+1.84
Flavor	9.1+0.99	9.5+0.52	9.1+0.99	7.3+1.94
Overall Acceptability	8.9+1.19	9.4+0.51	8.9+1.19	7.8+1.81

**Table 3: Nutritional composition of Sample B of developed Iron-rich Vermicelli**

S. No.	Nutritional Components	Amount
1.	Moisture (%)	9.3
2.	Carbohydrates (%)	68.18
3.	Fat (%)	1.85
4.	Proteins (%)	10.45
5.	Fibre (%)	3.11
6.	Mineral Ash (%)	0.78
7	Iron (mg/100g)	4.25

**Table 4: Cooking Quality of the developed samples of Iron-rich Vermicelli**

Samples	Cooking Time (Minutes)	Cooking Loss (%)	Swelling Index (ml/g)	Water Absorption (%)
Sample A	5.45	10.45	1.85	150.33
Sample B	5.25	10.60	1.82	151.45
Sample C	5.25	12.25	1.82	151.56
Sample D	5.15	12.65	1.69	152.33